NFPA 51B
Standard for
Fire Prevention During Welding, Cutting, and Other Hot Work
2003 Edition

This edition of NFPA 51B, Standard for Fire Prevention During Welding, Cutting, and Other Hot Work, was prepared by the Technical Committee on Hot Work Operations and acted on by NFPA at its May Association Technical Meeting held May 18–21, 2003, in Dallas, TX. It was issued by the Standards Council on July 18, 2003, with an effective date of August 7, 2003, and supersedes all previous editions.
This edition of NFPA 51B was approved as an American National Standard on July 18, 2003.
Origin and Development of NFPA 51B
This standard was tentatively adopted at the 1960 NFPA Annual Meeting, and the first edition was adopted in 1962. Subsequent editions were published in 1971, 1976, 1977, 1984, 1989, and 1994. The 1999 edition was expanded to include other hot work operations, as defined in the document, to clarify the roles of fire watch, and to introduce a defined permit authorizing individual.
The 2003 edition has been modified to incorporate the following additions: a clear reference to ANSI Z49.1, Safety in Welding, Cutting, and Allied Processes, to ensure other non-fire-related hot work requirements are followed; a requirement for signs designating hot work areas as needed; further clarification in the annex of the role of fire watch and also more advisory material describing management responsibilities; requirements for consideration on non-horizontal spark or slag travel hazard; requirements and advisory material for the consideration of personal protective equipment; decision trees for: (a) when a permit is needed, and (b) when a fire watch is needed; and a new chapter, “Sole Proprietors and Individual Operators,” to consider the “one-person shops.” This edition has also been modified to comply with the updated NFPA Manual of Style.
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NOTE: Membership on a committee shall not in and of itself constitute an endorsement of the Association or any document developed by the committee on which the member serves.
Committee Scope: This Committee shall have primary responsibility for documents on the prevention of loss of life and property from fire or explosion as a result of hot work. Hot work operations include, but are not limited to, cutting, welding, burning, or similar operations capable of initiating fire or explosion.
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NOTICE: An asterisk (*) following the number or letter designating a paragraph indicates that explanatory material on the paragraph can be found in Annex A.
Changes other than editorial are indicated by a vertical rule beside the paragraph, table, or figure in which the change occurred. These rules are included as an aid to the user in identifying changes from the previous edition. Where one or more complete paragraphs have been deleted, the deletion is indicated by a bullet (•) between the paragraphs that remain.
A reference in brackets [ ] following a section or paragraph indicates material that has been extracted from another NFPA document. As an aid to the user, Annex C lists the complete title and edition of the source documents for both mandatory and nonmandatory extracts. Editorial changes to extracted material consist of revising references to an

appropriate division in this document or the inclusion of the document number with the division number when the reference is to the original document. Requests for interpretations or revisions of extracted text shall be sent to the technical committee responsible for the source document.
Information on referenced publications can be found in Chapter 2 and Annex C.

Chapter 1 Administration

1.1 Scope.

1.1.1* This standard shall cover provisions to prevent loss of life and property from fire or explosion as a result of hot work.
1.1.2 Installation and operation of arc cutting and welding equipment and operation of gas cutting and welding equipment shall be in accordance with ANSI Z49.1, Safety in Welding, Cutting, and Allied Processes.

1.2 Purpose.

This standard shall provide guidance for persons, including outside contractors and property managers, who manage, supervise, and perform hot work.

1.3 Application.

1.3.1 This standard shall apply to the following hot work processes:
(1) Welding and allied processes
(2) Heat treating
(3) Grinding
(4) Thawing pipe
(5) Powder-driven fasteners
(6) Hot riveting
(7)* Torch-applied roofing in conjunction with the requirements of NFPA 241, Standard for Safeguarding Construction, Alteration, and Demolition Operations
(8) Similar applications producing or using a spark, flame, or heat
1.3.2 This standard shall not apply to the following:
(1) Candles
(2) Pyrotechnics or special effects
(3) Cooking operations
(4) Electric soldering irons
(5) Design and installation of gas cutting equipment and welding equipment covered in NFPA 51, Standard for the Design and Installation of Oxygen–Fuel Gas Systems for Welding, Cutting, and Allied Processes
(6) Additional requirements for hot work operations in confined spaces
(7) Lockout/tagout procedures during hot work

1.4 Retroactivity.

The provisions of this standard reflect a consensus of what is necessary to provide an acceptable degree of protection from the hazards addressed in this standard at the time the standard was issued.
1.4.1 Unless otherwise specified, the provisions of this standard shall not apply to facilities, equipment, structures, or installations that existed or were approved for construction or installation prior to the effective date of the standard. Where specified, the provisions of this standard shall be retroactive.

1.4.2 In those cases where the authority having jurisdiction determines that the existing situation presents an unacceptable degree of risk, the authority having jurisdiction shall be permitted to apply retroactively any portions of this standard deemed appropriate.
1.4.3 The retroactive requirements of this standard shall be permitted to be modified if their application clearly would be impractical in the judgment of the authority having jurisdiction, and only where it is clearly evident that a reasonable degree of safety is provided.
1.5 Equivalency.
Nothing in this standard is intended to prevent the use of systems, methods, or devices of equivalent or superior quality, strength, fire resistance, effectiveness, durability, and safety over those prescribed by this standard.
1.5.1 Technical documentation shall be submitted to the authority having jurisdiction to demonstrate equivalency.
1.5.2 The system, method, or device shall be approved for the intended purpose by the authority having jurisdiction.
Chapter 2 Referenced Publications
2.1 General.
The documents or portions thereof listed in this chapter are referenced within this standard and shall be considered part of the requirements of this document.
2.2 NFPA Publications.
National Fire Protection Association, 1 Batterymarch Park, P.O. Box 9101, Quincy, MA 02269-9101.
NFPA 25, Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems, 2002 edition.
NFPA 51, Standard for the Design and Installation of Oxygen–Fuel Gas Systems for Welding, Cutting, and Allied Processes, 2002 edition.
NFPA 55, Standard for the Storage, Use, and Handling of Compressed Gases and Cryogenic Fluids in Portable and Stationary Containers, Cylinders, and Tanks, 2003 edition.
NFPA 241, Standard for Safeguarding Construction, Alteration, and Demolition Operations, 2000 edition.
2.3 Other Publications.
2.3.1 ANSI Publication.
American National Standards Institute, Inc., 11 West 42nd Street, 13th Floor, New York, NY 10036.
ANSI Z49.1, Safety in Welding, Cutting, and Allied Processes, 1999.
Chapter 3 Definitions
3.1 General.
The definitions contained in this chapter shall apply to the terms used in this standard. Where terms are not included, common usage of the terms shall apply.
3.2 NFPA Official Definitions.
3.2.1* Approved. Acceptable to the authority having jurisdiction.
3.2.2* Authority Having Jurisdiction (AHJ). An organization, office, or individual responsible for enforcing the requirements of a code or standard, or for approving equipment, materials, an installation, or a procedure.
3.2.3 Shall. Indicates a mandatory requirement.

3.2.4 Should. Indicates a recommendation or that which is advised but not required.
3.2.5 Standard. A document, the main text of which contains only mandatory provisions using the word “shall” to indicate requirements and which is in a form generally suitable for mandatory reference by another standard or code or for adoption into law. Nonmandatory provisions shall be located in an appendix or annex, footnote, or fine-print note and are not to be considered a part of the requirements of a standard.
3.3 General Definitions.
3.3.1 Designated Area. A permanent location designed or approved for hot work operations.
3.3.2 Hot Work. Work involving burning, welding, or a similar operation that is capable of initiating fires or explosions.
3.3.3 Management. For the purpose of hot work, all persons, including owners, contractors, educators, and so on, who are responsible for hot work operations.
3.3.4 Permit. A document issued by the authority having jurisdiction for the purpose of authorizing performance of a specified activity. [1:3.3]
3.3.5* Permit Authorizing Individual (PAI). The individual designated by management to authorize hot work.
3.3.6* Welding and Allied Processes. Processes such as arc welding, oxy–fuel gas welding, open-flame soldering, brazing, thermal spraying, oxygen cutting, and arc cutting.
Chapter 4 Responsibility for Hot Work
4.1* Management.
Management or a designated agent shall be responsible for the safe operations of hot work activity.
4.1.1 Management shall establish permissible areas for hot work.
4.1.2 Management shall designate a permit authorizing individual (PAI).
4.1.3 All equipment shall be examined to ensure it is in a safe operating condition.
4.1.4 When found to be incapable of reliable safe operation, the equipment shall be repaired by qualified personnel prior to its next use or be withdrawn from service.
4.1.5 Management shall ensure that only approved apparatus, such as torches, manifolds, regulators or pressure-reducing valves, and acetylene generators, are used.
4.1.6 Management shall ensure that all individuals involved in the hot work operations, including contractors, are familiar with the provisions of this standard.
4.1.6.1 Individuals involved in hot work operations shall be trained in the safe operation of their equipment and in the safe use of the process.
4.1.6.2 Individuals involved in hot work operations shall have an awareness of the inherent risks involved and understand the emergency procedures in the event of a fire.
4.1.7 Management shall advise all contractors about site-specific flammable materials, hazardous processes or conditions, or other potential fire hazards.
4.2 Permit Authorizing Individual (PAI).
In conjunction with management, the PAI shall be responsible for the safe operation of hot work activities.
4.2.1 The PAI shall determine site-specific flammable materials, hazardous processes, or other potential fire hazards that are present or likely to be present in the work location.
4.2.2 The PAI shall ensure the protection of combustibles from ignition by the following means:

(1) Moving the work to a location that is free from combustibles
(2) If the work cannot be moved, moving the combustibles to a safe distance or having the combustibles properly shielded against ignition
(3) Scheduling hot work so that operations that could expose combustibles to ignition are not begun during hot work operations

4.2.3* If the criteria of 4.2.2(1), (2), or (3) cannot be met, hot work shall not be performed.

4.2.4 The PAI shall determine that fire protection and extinguishing equipment are properly located at the site.

4.2.5 Where a fire watch is required (see Section 5.4), the PAI shall be responsible for ensuring that a fire watch is at the site.

4.2.6* Where a fire watch is not required, the PAI shall make a final check ½ hour after the completion of hot work operations to detect and extinguish smoldering fires.

4.3 Hot Work Operator.

The hot work operator shall handle equipment safely and use it as follows so as not to endanger lives and property:

(1) The operator shall have the PAI's approval before starting hot work operations.
(2) All equipment shall be examined to ensure it is in a safe operating condition, and, if found to be incapable of reliable safe operation, the equipment shall be repaired by qualified personnel prior to its next use or be withdrawn from service.
(3) The operator shall cease hot work operations if unsafe conditions develop and shall notify management, the area supervisor, or the PAI for reassessment of the situation.

4.4 Fire Watch.

4.4.1* The fire watch shall be trained to understand the inherent hazards of the work site and of the hot work.

4.4.2 The fire watch shall ensure that safe conditions are maintained during hot work operations.

4.4.3 The fire watch shall have the authority to stop the hot work operations if unsafe conditions develop.

4.4.4* The fire watch shall have fire-extinguishing equipment readily available and shall be trained in its use.

4.4.5 The fire watch shall be familiar with the facilities and procedures for sounding an alarm in the event of a fire.

4.4.6 The fire watch shall watch for fires in all exposed areas and try to extinguish them only when the fires are obviously within the capacity of the equipment available. If the fire watch determines that the fire is not within the capacity of the equipment, the fire watch shall sound the alarm immediately.

4.4.7* The fire watch shall be permitted to perform additional tasks, but those tasks shall not distract him or her from his or her fire watch responsibilities, except as outlined in Chapter 6.

4.5 Mutual Responsibility.

Management, contractors, the PAI, the fire watch, and the operators shall recognize their mutual responsibility for safety in hot work operations.

Chapter 5 Fire Prevention Precautions

5.1 Permissible Areas.

5.1.1 General. Hot work shall be permitted only in areas that are or have been made fire safe.
5.1.2 Designated or Permit-Required Areas. Hot work shall be performed in either designated areas or permit-required areas.
5.1.2.1 Designated Areas. A designated area shall be a specific area designed or approved for hot work, such as a maintenance shop or a detached outside location that is of noncombustible or fire-resistive construction, essentially free of combustible and flammable contents, and suitably segregated from adjacent areas.
5.1.2.2 Permit-Required Areas.
5.1.2.2.1 A permit-required area shall be an area that is made fire safe by removing or protecting combustibles from ignition sources.
5.1.2.2.2 Signs shall be posted designating hot work areas as deemed necessary by the PAI.
5.2* Nonpermissible Areas.
Hot work shall not be permitted in the following areas:
(1) In areas not authorized by management
(2) In sprinklered buildings where sprinklers are impaired, unless the requirements of NFPA 25, Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems, are met
(3) In the presence of explosive atmospheres (i.e., where mixtures of flammable gases, vapors, liquids, or dusts with air exist)
(4) In the presence of uncleaned or improperly prepared drums, tanks, or other containers and equipment that have previously contained materials that could develop explosive atmospheres
(5) In areas with an accumulation of combustible dusts that could develop explosive atmospheres
5.3* Hot Work Permit.
5.3.1* Before hot work operations begin in a nondesignated location, a written hot work permit by the permit authorizing individual (PAI) shall be required.
5.3.2 Before a hot work permit is issued, the following conditions shall be verified by the PAI:
(1) The hot work equipment to be used shall be in satisfactory operating condition and in good repair.
(2) Where combustible materials, such as paper clippings, wood shavings, or textile fibers, are on the floor, the floor shall be swept clean for a radius of 11 m (35 ft) and the following criteria also shall be met:
(a) Combustible floors (except wood on concrete) shall be kept wet, covered with damp sand, or protected by noncombustible or fire-retardant shields.
(b) Where floors have been wet down, personnel operating arc welding equipment or cutting equipment shall be protected from possible shock.
(3)* All combustibles shall be relocated at least 11 m (35 ft) in all directions from the work site and the following criteria also shall be met:
(a) If relocation is impractical, combustibles shall be protected with fire-retardant covers or otherwise shielded with metal or fire-retardant guards or curtains.

(b) The edges of covers at the floor shall be tight to prevent the entrance of sparks, including at the point at which several covers overlap where a large pile is being protected.
(4) Openings or cracks in walls, floors, or ducts within 11 m (35 ft) of the site shall be tightly covered with fire-retardant or noncombustible material to prevent the passage of sparks to adjacent areas.
(5) Ducts and conveyor systems that might carry sparks to distant combustibles shall be shielded, or shut down, or both.
(6) If hot work is done near walls, partitions, ceilings, or roofs of combustible construction, fire-retardant shields or guards shall be provided to prevent ignition.
(7) If hot work is done on one side of a wall, partition, ceiling, or roof, one of the following criteria shall be met:
(a) Precautions shall be taken to prevent ignition of combustibles on the other side by relocating the combustibles.
(b) If it is impractical to relocate combustibles, a fire watch shall be provided on the side opposite from where the work is being performed.
(8) Hot work shall not be attempted on a partition, wall, ceiling, or roof that has a combustible covering or insulation, or on walls or partitions of combustible sandwich-type panel construction.
(9) Hot work that is performed on pipes or other metal that is in contact with combustible walls, partitions, ceilings, roofs, or other combustibles, shall not be undertaken if the work is close enough to cause ignition by conduction.
(10) Fully charged and operable fire extinguishers that are appropriate for the type of possible fire shall be available immediately at the work area.
(11) If existing hose lines are located within the hot work area defined by the permit, they shall be connected and ready for service but shall not be required to be unrolled or charged.
(12) The following shall apply to hot work done in close proximity to a sprinkler head:
(a) A wet rag shall be laid over the sprinkler head and then removed at the conclusion of the welding or cutting operation.
(b) During hot work, special precautions shall be taken to avoid accidental operation of automatic fire detection or suppression systems (e.g., special extinguishing systems or sprinklers).
(13) Nearby personnel shall be suitably protected against dangers such as heat, sparks, and slag.
5.3.3* Based on local conditions, the PAI shall determine the length of the period for which the hot work permit is valid.
5.3.4* The area shall be inspected by the PAI at least once per day while the hot work permit is in effect to ensure that it is a fire-safe area.
5.4 Fire Watch.
5.4.1* A fire watch shall be required by the PAI when hot work is performed in a location where other than a minor fire might develop or where the following conditions exist:
(1)* Combustible materials in building construction or contents are closer than 11 m (35 ft) to the point of operation.

(2) Combustible materials are more than 11 m (35 ft) away from the point of operation but are easily ignited by sparks.
(3) Wall or floor openings within an 11-m (35-ft) radius expose combustible materials in adjacent areas, including concealed spaces in walls or floors.
(4) Combustible materials are adjacent to the opposite side of partitions, walls, ceilings, or roofs and are likely to be ignited.
5.4.2* A fire watch shall be maintained for at least ½ hour after completion of hot work operations in order to detect and extinguish smoldering fires.
5.4.3* More than one fire watch shall be required if combustible materials that could be ignited by the hot work operation cannot be directly observed by the initial fire watch.
5.5* Hot Tapping.
Hot tapping or other cutting and welding on a flammable gas or liquid transmission or distribution utility pipeline shall be performed by a crew that is qualified to make hot taps.
5.6 Cylinders.
Cylinder use and storage shall be in accordance with NFPA 55, Standard for the Storage, Use, and Handling of Compressed Gases and Cryogenic Fluids in Portable and Stationary Containers, Cylinders, and Tanks.
5.7* Personal Protective Clothing.
Clothing shall be selected to minimize the potential for ignition, burning, trapping hot sparks, or electric shock.
Chapter 6 Sole Proprietors and Individual Operators
6.1* Assignment of PAI and Fire Watch.
In a site where hot work operations are not under the control of another authority, the individual hot work operator shall be permitted to serve as PAI and fire watch, provided that the operator is trained and follows the provisions of this standard.
6.2 Written Hot Work Permit.
A checklist shall be permitted to serve as the written hot work permit.
Chapter 7 Public Exhibitions and Demonstrations
7.1 Application.
The provisions of this chapter shall apply to oxy–fuel gas welding and cutting operations at public exhibitions, demonstrations, displays, and trade shows, referred to hereinafter as the “site,” in order to promote the safe use of compressed gases in public gatherings.
7.2 Supervision.
Installation and operation of welding, cutting, and related equipment shall be done by, or under the supervision of, a competent operator, to ensure the personal protection of viewers and demonstrators as well as the protection from fire of materials in and around the site and the building itself.
7.3 Site.
7.3.1 Location. Sites involving the use and storage of compressed gases shall be located so as not to interfere with egress during an emergency.
7.3.2 Design. The site shall be constructed, equipped, and operated in such a manner that the demonstration minimizes the possibility of injury to viewers.
7.4 Fire Protection.
7.4.1 Fire Extinguishers. Each site shall be provided with a portable fire extinguisher of appropriate size and type and with a pail of water.

7.4.2 Shielding. The public, combustible materials, and compressed gas cylinders at the site shall be protected from flames, sparks, and molten metal.
7.4.3 Fire Department Notification. The fire department shall be notified in advance of the use of a site for public exhibitions, demonstrations, and trade shows.
7.5 Cylinders.
7.5.1 Gas Capacity Limitation.
7.5.1.1 Cylinders containing compressed gases for use at the site shall not be charged in excess of one-half their maximum permissible content.
7.5.1.2 Cylinders of nonliquefied gases and acetylene shall be charged to not more than one-half their maximum permissible charged gauge pressure (kPa or psi).
7.5.1.3 Cylinders of liquefied gases shall be charged to not more than one-half the maximum permissible capacity in kilograms (pounds).
7.5.2 Storage.
7.5.2.1 Cylinders located at the site shall be connected for use.
7.5.2.2 A sufficient number of additional cylinders shall be permitted to be stored at the site to furnish approximately one day's consumption of each gas used.
7.5.2.3* Other cylinders shall be stored in an approved storage area, but not near a building exit.
7.5.3 Transporting Cylinders. Cylinders in excess of 18 kg (40 lb) total weight being transported to or from the site shall be carried on a hand truck or motorized truck.
7.5.4 Process Hose. Process hose shall be located and protected so that they will not be physically damaged.
7.5.5 Cylinder Valves. Cylinder valves shall be closed when equipment is unattended.
7.5.6 Valve Caps. If cylinders are designed to be equipped with valve protection caps, such caps shall be in place, except when the cylinders are in service or are connected and ready for service.
7.5.7 Cylinder Protection. Cylinders shall be secured so that they cannot be knocked over.
Annex A Explanatory Material
Annex A is not a part of the requirements of this NFPA document but is included for informational purposes only. This annex contains explanatory material, numbered to correspond with the applicable text paragraphs.
A.1.1.1 Cutting and welding processes using electric arcs or oxy–fuel gas flames are a necessary part of our industrial world. Too often, however, the persons who use, contract, or supervise the use of these processes do not fully appreciate that their improper use can result in loss of life and property by fire and explosion.
Approximately 6 percent of fires in industrial properties and many fires in other properties have been caused by cutting and welding, primarily with portable equipment in areas not specifically designed or approved for such work. Cutting and certain arc welding operations produce literally thousands of ignition sources in the form of sparks and hot slag. Electric arcs or oxy–fuel gas flames and hot work pieces are also inherent ignition sources.
The majority of fires in which cutting and welding are factors have been caused by sparks. These globules of molten metal have scattered horizontally as far as 11 m (35 ft), setting fire to all kinds of combustible materials. They have also fallen through cracks,

pipe holes, or other small openings in floors and partitions, starting fires that have reached serious proportions before being noticed.

Electric arcs or oxy–fuel gas flames, in themselves, have rarely caused fire except where they have overheated combustibles in the vicinity of the work or where they have been used on containers that have held combustibles without having been cleaned and purged. In the latter case, an explosion generally resulted.

The heat of the metal being welded or cut has caused fires where the hot pieces were permitted to rest or fall upon combustible materials. Fires and explosions have also been caused where such heat has been transmitted, as in the case of a container, through the metal to a flammable atmosphere or to combustibles within the container.

Anything that is combustible or flammable is susceptible to ignition by cutting and welding. The most common materials likely to become involved in fire are those of combustible building construction such as the following:

(1) Floors, partitions, and roofs

(2) Combustible contents such as wood, paper, textiles, plastics, chemicals, and flammable liquids and gases

(3) Combustible ground cover such as grass and brush

Preventing hot work fires can best be achieved by separating combustibles from ignition sources or by shielding combustibles.

A.1.3.1(7) There are more detailed and in some cases more stringent requirements for torch-applied roofing found in NFPA 241, Standard for Safeguarding Construction, Alteration, and Demolition Operations.

A.3.2.1 Approved. The National Fire Protection Association does not approve, inspect, or certify any installations, procedures, equipment, or materials; nor does it approve or evaluate testing laboratories. In determining the acceptability of installations, procedures, equipment, or materials, the authority having jurisdiction may base acceptance on compliance with NFPA or other appropriate standards. In the absence of such standards, said authority may require evidence of proper installation, procedure, or use. The authority having jurisdiction may also refer to the listings or labeling practices of an organization that is concerned with product evaluations and is thus in a position to determine compliance with appropriate standards for the current production of listed items.

A.3.2.2 Authority Having Jurisdiction (AHJ). The phrase “authority having jurisdiction,” or its acronym AHJ, is used in NFPA documents in a broad manner, since jurisdictions and approval agencies vary, as do their responsibilities. Where public safety is primary, the authority having jurisdiction may be a federal, state, local, or other regional department or individual such as a fire chief; fire marshal; chief of a fire prevention bureau, labor department, or health department; building official; electrical inspector; or others having statutory authority. For insurance purposes, an insurance inspection department, rating bureau, or other insurance company representative may be the authority having jurisdiction. In many circumstances, the property owner or his or her designated agent assumes the role of the authority having jurisdiction; at government installations, the commanding officer or departmental official may be the authority having jurisdiction.

A.3.3.5 Permit Authorizing Individual (PAI). The PAI is permitted to be, among others, the supervisor, foreperson, property owner or representative, or health and safety

administrator. The PAI cannot be the hot work operator, except as permitted in Chapter 6. The PAI is aware of the fire hazards involved and is familiar with the provisions of this standard.

A.3.3.6 Welding and Allied Processes. The "Master Chart of Welding and Allied Processes" in ANSI Z49.1, Safety in Welding, Cutting, and Allied Processes, includes a list of welding and allied processes.

A.4.1 The committee recognizes that management might not always have expertise in hot work and, therefore, would need a knowledgeable designated agent or contractor to act on its behalf. Examples of those who might not have the expertise can include owners of small retail shops, a small apartment complex manager, or a grocery store owner who has no knowledge of hot work safe practices.

Management should ensure that the contractor has evidence of financial responsibility, which can take the form of an insurance certificate or other document attesting to coverage or responsibility.

A.4.2.3 Alternate methods to hot work should be considered where practical.

A.4.2.6 The inspection is usually made ½ hour after the completion of hot work to detect and extinguish possible smoldering fires. The inspector should be alert for circumstances that can require an extension of the final inspection interval.

A.4.4.1 The fire watch duties can be assigned to anyone who understands the hazard of the hot work being performed and the limitations placed on that hot work operation by the person issuing the hot work permit (PAI). The fire watch has the responsibility to make certain the hot work area is maintained in a fire-safe condition throughout performance of the hot work and has the authority to stop the hot work if unsafe conditions are observed. The fire watch must understand the basic hazards of any combustible construction involved with the hot work area, the fire exposure hazard hot work creates to occupancies adjacent to or below the hot work operation, the hazards associated with the occupancy, and the need to maintain proper isolation of all hot work operations from combustible or flammable materials. The fire watch should also be properly trained in use of manual, portable fire extinguishers and emergency notification procedures within the facility. The fire watch is not a replacement for proper planning to prevent conditions that allow a fire to develop, regardless of the fire-fighting equipment available and the capabilities of the individuals involved.

A.4.4.4 The fire watch should have experience with test fires.

A.4.4.7 These tasks might include moving partitions relating to the hot work, sweeping in the immediate area, and minimal assistance to the operator.

A.5.2 For additional information on cutting and welding of containers that have held flammable materials, see NFPA 326, Standard for the Safeguarding of Tanks and Containers for Entry, Cleaning, or Repair, and AWS F-4.1, Recommended Safe Practices for the Preparation for Welding and Cutting Containers and Piping.

Additional consideration should be given when performing hot work in areas near the storage of large quantities of exposed, readily ignitable materials such as bulk sulfur, baled paper, or cotton. For additional information on welding and cutting in storage areas, refer to NFPA 230, Standard for the Fire Protection of Storage, and NFPA 655, Standard for Prevention of Sulfur Fires and Explosions.

A.5.3 The decision tree in Figure A.5.3 can be used to determine if a hot work permit is necessary.

FIGURE A.5.3 Hot Work Permit Decision Tree.

A.5.3.1 Examples of hot work permits are shown in Figure A.5.3.1(a) and Figure A.5.3.1(b). These permits can be modified to suit local conditions.

FIGURE A.5.3.1(a) Sample of a Hot Work Permit.

FIGURE A.5.3.1(b) Another Sample of a Hot Work Permit. (©1992, Factory Mutual Engineering Corporation. Reprinted with Permission.)

A.5.3.2(3) When hot work is performed at an elevated level, it should be noted that the sparks or slag can fall at a trajectory and land further than 11 m (35 ft) horizontally from a point directly under the hot work operator.

A.5.3.3 It is advisable that the permit should be issued for a maximum period of 24 hours.

A.5.3.4 In some situations, it is advisable to inspect the area once per shift if conditions warrant.

A.5.4.1 The decision tree in Figure A.5.4.1 can be used to determine if a fire watch is necessary.

FIGURE A.5.4.1 Fire Watch Decision Tree.

A.5.4.1(1) Figure A.5.4.1(1) demonstrates the hot work 11-m (35-ft) rule.

FIGURE A.5.4.1(1) The Hot Work 11-m (35-ft) Rule. (Courtesy of Factory Mutual Engineering Corporation.)

A.5.4.2 Management, the PAI, or the operator can extend the duration of the fire watch based on fire hazards or work being performed.

A.5.4.3 An additional fire watch(es) might be necessary in certain situations, such as where hot work is performed near open shafts, or at elevated heights or where sparks can travel through spaces such as openings.

A.5.5 For hot tapping on a gas pipeline, see ASME B31.8, Gas Transmission and Distribution Piping Systems.

A.5.7 Heavier materials such as woolen clothing or heavy cotton are preferable to lighter materials because they are more difficult to ignite. Cotton clothing, if used for protection, should be chemically treated to reduce its combustibility. Clothing treated with flame-resistant materials can lose some of its protective characteristics after repeated washing or cleaning. Materials that can melt and cause severe burns should not be used as clothing when welding or cutting.

Sparks can lodge in rolled-up sleeves, pockets of clothing, or cuffs of overalls or trousers. Therefore, it is recommended that sleeves and collars be kept buttoned and pockets be eliminated from the front of clothing. Where pockets are present, they should be emptied of flammable or readily combustible materials. Trousers or overalls should not have cuffs and should not be turned up on the outside. Trousers should overlap shoe tops to prevent spatter from getting inside shoes.

Frayed clothing is particularly susceptible to ignition and burning and should not be worn when welding or cutting.

A.6.1 A common example of a situation where this chapter would apply is work performed in a single-dwelling home by a plumber sweating a pipe. Another example is the repair of a wrought iron railing used for steps in a single-dwelling home. A third example is welding performed on construction or agricultural equipment on site. The committee recognizes that it is not always practical to have more than one individual present, and completing a job with one person is a common practice. The committee stresses that it is always better to have more than one individual present to ensure fire safety, but realizes that it is not always practical to do so.

A.7.5.2.3 The preferred location for cylinder storage is in an approved storage area outdoors.

Annex B Significant Hot Work Incidents

This annex is not a part of the requirements of this NFPA document but is included for informational purposes only.

B.1

Hot work processes are a necessary part of our industrial world. Too often, however, the persons (users, supervisors, contractors) involved with these processes do not fully appreciate that their improper use can result in loss of life and property from fire and explosion. In fact, hot work performed improperly is a major cause of fire.

B.2

Annex B is a collection of accounts of fires and explosions caused by improper control of hot work. The sole purpose of this annex is to illustrate how such incidents occur and to emphasize the provisions of this standard.

B.2.1 Kaukauna, WI, Warehouse. While an arc welder was being used on the second floor, sparks dropped through an opening to cardboard boxes below and the boxes ignited. There was no fire watch on the first floor, and when the fire was discovered 15 minutes later, employees could not put it out. They finally called the fire department, but were too late to save the two-story building of ordinary construction. The total loss was $1.6 million.

B.2.2 Winnipeg, Manitoba, Food Processing. While an employee was using an oxyacetylene cutting torch to modify a bracket in the boiler room, hot slag ignited canvas and plywood that were being used as a temporary covering over a hole in the wall between the fire-resistive boiler room and the storage room. Fire then spread to waxed cartons and plastic bags in the storage room. Fire fighting was impeded by the windowless walls and thick black smoke. The total loss was $650,000.

B.2.3 Halsey, OR, Rolled Paper Storage. A bracket was being welded onto a column adjacent to an aisle, with rolled paper storage not more than 1.5 m (5 ft) away. A welding permit was reportedly issued for the work, but the standard permit form clearly stated that combustibles within 11 m (35 ft) of the work should be removed or shielded. The permit also required the signature of the supervisor certifying that a check of the area had been made. In this case, there was no protection for the combustibles and no signature.

The fire quickly spread into the interior of the storage pile, but sprinklers operated, roof vents were opened, and hose streams were brought into play as the smoke cleared a little. About 300 rolls were burned beyond salvage, and other rolls were wet. The total loss was $250,000.

B.2.4 Atlanta, GA, Poultry Processing. An employee using an electric arc welder was working in an area above a refrigerated room, which was insulated with polyurethane

foam sandwiched between sheets of aluminum. Sparks fell on the exposed ends of the insulation, causing a severe fire. The heat was sufficient to bring about the collapse of exposed metal bar joist roof framing, and the total loss was $250,000.

B.2.5 Ontario, OR, Food Processing. An oxyacetylene cutting torch was being used in a metal-lined freezing tunnel, with some pipes passing through the walls of the tunnel and making a loose fit with these walls. Sparks evidently passed through a crack to ignite polystyrene foam insulation. The ignition occurred during a rest period and was not discovered until the rest period was over. Further time was lost during a fruitless effort to extinguish the fire with extinguishers and a small hose. The fire department, when finally called, was confronted with a tough task due to the heavy smoke and the spread of fire to the concealed and undivided attic space. The total loss was $2.3 million.

B.2.6 San Pedro, CA, Wharf. Workers were using a gasoline-powered chain saw and cutting torch to repair pilings on a 1128-m (3700-ft) long wharf. While some of the workers were refueling the chain saw from a 7.6-L (2-gal) can, another worker was using a cutting torch far too close to the refueling operation. Gasoline vapors ignited and, during efforts to extinguish the fire, the can was kicked into the water. Burning gas in the water ignited the pilings, and flames spread 113 m (370 ft) along the underside of the wharf before fire fighters could control the fire.

B.2.7 Portland, OR, Lumber Mill. Workers had shut down one of several sprinkler systems in the plant to remove branch lines to facilitate removal of a conveyor. While workers were cutting bolts from the conveyor with welding equipment, some of the sparks passed through cracks in the floor and landed in sawdust accumulations below. Smoldering occurred for 3 hours without being noticed by the maintenance employees, who were the only people in the plant. Meanwhile, the area in the region of the cutting operations, but not the floor below, had been washed down and visited regularly at ½-hour intervals.

When the fire was finally noticed, some time was spent in trying to extinguish it before the fire department was called. By the time the fire department arrived, it was too late to save the lumber storage and stacker buildings. Destruction caused a total loss of $1.25 million.

B.2.8 Austin, TX, University Library. Workers were using an acetylene torch to remove old heating ducts in a utility shaft between the twentieth and twenty-first stories of the tower of a twenty-seven-story university library building. Flying sparks fell through a vent and ignited papers stacked against the vent in a storage room on the twentieth floor. Apparently the fire burned for 20 minutes to 30 minutes before discovery.

There was no fire protection in the upper stories, except for portable fire extinguishers, and fire fighters had to connect to the standpipes in the third and fourth stories and pull hose lines up the enclosed stairways to the twentieth and twenty-first stories. They finally controlled the fire in 2½ hours, but damage extended to four stories when fire spread by way of nonfirestopped utility shafts and elevator shafts.

The work was being done by two air-conditioning installation workers, on contract. They had not investigated the possibility of combustible material being in contact with the old heating duct on which they were working.

B.2.9 Atlanta, GA, Wire and Nail Mill. A small fire started on the mill's built-up wood roof while repairs were made using an acetylene torch for welding. The workers making the repairs believed that they had extinguished the fire, but 3½ hours later the fire broke

out again and spread on an accumulation of metal dust on overhead beams throughout the unsprinklered, undivided single-story structure. The total loss was $2.3 million.

B.2.10 Provo, UT, Hardware Warehouse. An employee was welding a broken metal roof beam in the attic of a one-story brick, wood-joisted, wholesale hardware building. A spark fell through a crack in the attic floor and ignited cardboard boxes in the shelving below. No precautions had been taken to guard against fire, and the welder did not realize that there was a fire until he felt the heat coming up from below. The total loss was $131,000.

B.2.11 Thomson, NY, Paper Mill. Production lines were shut down in a tissue paper mill so that maintenance workers could use a cutting torch to remove a drive roll for repairs. The area where the cutting was to be done was cleaned up and wet down as a precaution against flying sparks. Also, an employee with a portable extinguisher acted as fire watch during the cutting operation.

A stray spark ignited paper dust on the floor at the adjacent machine. When the fire watch attempted to extinguish the small blaze, he found that his portable extinguisher was empty. The blaze spread to paper dust and lint on top of an unused overhead heating duct, which was 0.6 m to 1.5 m (2 ft to 5 ft) in diameter. It took fire fighters about 3 hours to extinguish the blaze in the unsprinklered duct. The damage to tissue paper by fire-fighting operations amounted to $25,000.

B.2.12 Jacksonville, IL, Pavement Manufacturing. After partially unloading a tanker of MC 800 road oil at a temperature of about 290°F (143°C), two employees went to the top of the asphalt tank to straighten a pipe through which they measured the oil level. They were using an acetylene torch for this repair work. The torch so heated the top of the tank that flammable vapors within the tank exploded and tore up a large part of the top. Both men were thrown long distances and killed.

B.2.13 Toledo, OH, Tar Manufacturing. Welders were repairing a leak in an odor-scrubbing system when an explosion occurred in a tank connected with the system and containing naphthalene vapors above the hot tar level. It is believed that heat from the torch ignited flammable vapors within the pipe and that the flame was propagated to the tank. The spread of hot tar when the tank ruptured handicapped fire fighters in gaining quick access to the area. Three workers were killed and property damage was $110,000.

B.2.14 New Orleans, LA, Office Building. An outside contractor installing new elevator equipment in a seven-story office building with plank floors set a number of fires as a result of cutting and welding operations, but the contractor's employees extinguished all but one. That fire occurred toward the end of the day's work, and the four employees, without discovering the fire, went home. Later in the evening, the night porter noticed the old elevator penthouse, which was partly of wooden construction, ablaze as he was summoning the elevator to perform his normal duties. Two hours later, the fire department, using many large hose lines, brought the fire under control. The loss, mainly to the top story from fire and to lower stories from water, was $530,000.

There was no formal fire watch nor, following the last use of the welder, was there any inspection of the area during a set period after the welding.

B.2.15 Hatboro, PA, Chemical Plant. Workers were welding some additional fill-line supports on a 22,713-L (6000-gal) vertical tank containing 11,356 L (3000 gal) of alcohol. Heat transmitted through the metal of the tank ignited alcohol vapors inside, and

the tank was blown into the air. Alcohol was dumped into two diked areas containing eight tanks of high-flashpoint liquid, but heavy use of hose streams kept other tanks from rupturing. The total loss was $100,000.

B.2.16 New Orleans, LA, Candy Storage. The outside of the walls of this sprinklered metal-frame warehouse were lined with a combustible, laminated paper-asphalt vapor barrier and a 1.27-cm (½-in.) layer of foamed polystyrene insulation. A worker was welding metal plates to the base of the structural member when the combustible vapor barrier ignited. While the welder ran to turn in an alarm and to get a portable extinguisher, seven sprinklers operated to control the fire.

B.2.17 Billings, MT, Auditorium. While remodeling the auditorium at a fairground, workers were welding straps on channel iron, which had been placed on each side of 30.5 cm × 30.5 cm (12 in. × 12 in.) wooden uprights to provide more strength to the columns. Heat from the torch apparently caused some smoldering in the columns. Approximately 5 hours later, the caretaker noticed that the roof was ablaze. It was too late to save the building, which was of ordinary construction and nonsprinklered. The total loss was $266,000.

B.2.18 Sorel, PQ, Passenger Ship Under Construction. A shipyard worker was welding a steel bracket beneath the steel deck of a stateroom, when the hot deck plate ignited paper on the floor of the stateroom. Flames then spread to wooden paneling and other combustibles and soon reached synthetic rubber insulation on electrical cables and also resin-impregnated glass fiber ducts carrying 85 m3/min (3000 ft3/min) of warm air. Although a worker discovered the fire within a few minutes and the fans for the air ducts were quickly shut off, the heat and dense smoke from the burning resin and synthetic rubber prevented control. The fire spread from the promenade deck to three other decks. Damage to the vessel was $4 million.

B.2.19 San Francisco, CA, Marine Terminal. The reinforced concrete dock had a tar paper vapor barrier beneath the concrete and a wooden fenderline around the outside of the apron. Workers had a 30-day blanket welding and cutting permit but had not notified the port authority fire marshal that they planned to do cutting in the known dangerous area. They had also failed to take a portable extinguisher to the job with them. The two workers, while in a boat, were cutting a reinforcing rod beneath the apron when flame or sparks from the torch ignited the tar paper. The fire spread overhead so fast that the two men had to jump into the water to save themselves. The loss was estimated at $200,000.

B.2.20 Searcy, AR, Missile Silo. A welder in a missile silo under repair inadvertently allowed a temporarily installed steel-braided hose containing hydraulic oil under 3447.5 kPa (500 psi) in the range of the electric arc, which caused rupture of the steel braid and of the Teflon® inner tube. The escaping oil ignited at the arc, and a severe fire resulted in the confined underground space, fatally trapping 53 workers. The hose was only 36 cm (14 in.) away from the work being done, and working conditions were crowded and cramped.

After the accident, conditions were duplicated as nearly as possible at another site with proper protection of personnel. The time from the start of the arc at the hose to rupture was 0.69 seconds, and the time from rupture to ignition was 0.02 seconds.

B.2.21 River Rouge, MI, Metalworking. A worker was cutting an object with a torch, using the top of a drum containing kerosene as a workbench, when the torch cut into the

drum and caused an explosion in the partially full interior. The worker was fatally burned.

B.2.22 Port Maitland, Ontario, Fertilizer Manufacturing. Workers had been welding on a rubber-lined steel separator vessel. Reportedly, the rubber lining inside the vessel had been stripped from the metal tank wall where welding was to be done. A short time later, however, workers noticed smoke and discovered that the lining was burning. The fire spread from the vessel through several feet of rubber-lined duct connected to the vessel, and employees were unable to extinguish the fire on the vessel for approximately 45 minutes. The process equipment that was affected remained out of service for 2 weeks.

B.2.23 El Centro, CA, Hospital. During construction of a new hospital wing, sparks from a cutting torch being used to cut a steel beam in an existing wall ignited cellulose insulation in the attic of the existing single-story building. Although workers extinguished the fire before the fire department arrived [limiting firespread to a 6.1 m × 1.2 m (20 ft × 4 ft) area of insulation], it took 2 hours to remove smoke from the maternity ward.

The cellulose insulation had been treated with a fire retardant when installed 7 years prior to the fire. However, tests showed that much of its fire-retardant property had been lost.

B.2.24 Texas, Building Under Construction. During a late stage of construction of an apartment complex consisting of 23 two-story wooden buildings, heat from a plumber's torch ignited exterior low-density fiberboard sheathing on one of the buildings. The plumber had left the site approximately 1 hour before the fire was discovered and had not noticed fire or smoke in the area at that time. There was no fire watch procedure in effect. A watchman and a construction worker made an unsuccessful attempt to extinguish the fire before notifying the fire department. This delay and fire department operational problems with the new hydrant and yard main system resulted in extensive firespread, injuries to four fire fighters, and damage estimated at $400,000.

B.2.25 Montana, Lumber Mill. A fire started when sparks from a welding torch ignited a smoldering fire in a pile of sawdust. The night watchman who discovered the fire in the sawdust pile at 6:10 a.m. attempted to extinguish it using one of the hose lines, but, due to lack of maintenance, the hose burst. The watchman ran to another section of the building to get another hose. When he returned, the fire had spread and was out of control. He telephoned the fire department at 6:15 a.m. Officials stated that repair work, using a welding torch, was being done in the area of fire origin and had been completed approximately 1 hour prior to the discovery of the fire.

Contributing to the mill's destruction was the high concentration of unfinished lumber and sawdust, which helped increase the fire's spread. Fire officials stated that, if the occupant fire hose had been maintained, the loss, which was estimated at $500,000, might have been minimized.

B.2.26 Tennessee, Building Under Construction. A welder on the third floor of this construction project unknowingly started a fire on the floor below, which threatened other workers as well as the entire complex. The welder did not realize how far the globules of molten metal from his operation were traveling until another construction worker spotted a fire in some combustible material on the second floor at 1:44 p.m. The wind had carried the molten metal to the lower east wing and ignited one of four cardboard and wood crates, each of which contained a 379-L (100-gal) water heater. The workers tried to control the fire with portable extinguishers, but winds gusting up to 40

mph ended that prospect quickly. Someone on the site telephoned the fire department, and fire fighters had the situation stabilized soon after they arrived.
No one was injured, and only the building's contents were damaged. The loss was estimated at $10,000.
B.2.27 Michigan, Restaurant. A plumber, attempting to thaw some frozen water pipes in a newly constructed restaurant, inadvertently started a fire with an open-flame torch. The restaurant was a one-story, 669-m2 (7200-ft2) wood building. The torch ignited insulation material around the pipes, which were located above the kitchen ceiling. The plumber and several restaurant workers attempted to extinguish the fire with two 4.5-kg (10-lb) dry chemical fire extinguishers. When this attempt did not work, the local fire department was contacted as the fire moved quickly to the attic. The restaurant was determined to be a total loss, at a value of $525,000, and never opened for business.
B.2.28 Oak Ridge, TN, Demolition/Maintenance Worker. A welder was fatally burned while using a cutting torch to cut process piping to remove a converter from a building. Multilayer anticontamination clothing, cotton coveralls, and a full-face respirator prevented the welder from recognizing he was on fire. Lack of flame-retardant clothing, absence of a fire watch, and inadequate hot work procedures were identified as contributing to the incident. An investigation board concluded that had the welder's clothing been treated with flame-retardant chemicals, the fatality would not have occurred.
Annex C Informational References
C.1 Referenced Publications.
The following documents or portions thereof are referenced within this standard for informational purposes only and are thus not part of the requirements of this document unless also listed in Chapter 2.
C.1.1 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, P.O. Box 9101, Quincy, MA 02269-9101.
NFPA 230, Standard for the Fire Protection of Storage, 2003 edition.
NFPA 241, Standard for Safeguarding Construction, Alteration, and Demolition Operations, 2000 edition.
NFPA 326, Standard for the Safeguarding of Tanks and Containers for Entry, Cleaning, or Repair, 1999 edition.
NFPA 655, Standard for Prevention of Sulfur Fires and Explosions, 2001 edition.
C.1.2 Other Publications.
C.1.2.1 ANSI Publication. American National Standards Institute, Inc., 11 West 42nd Street, 13th Floor, New York, NY 10036.
ANSI Z49.1, Safety in Welding, Cutting, and Allied Processes, 1999.
C.1.2.2 ASME Publication. American Society of Mechanical Engineers, Three Park Avenue, New York, NY 10016-5990.
ASME B31.8, Gas Transmission and Distribution Piping Systems, 2000.
C.1.2.3 AWS Publication. American Welding Society, 550 N.W. LeJeune Road, Miami, FL 33126.
AWS F-4.1, Recommended Safe Practices for the Preparation for Welding and Cutting Containers and Piping, 1994.
C.2 Informational References. (Reserved)
C.3 References for Extracts.

The following documents are listed here to provide reference information, including title and edition, for extracts given throughout this standard as indicated by a reference in brackets [ ] following a section or paragraph. These documents are not a part of the requirements of this document unless also listed in Chapter 2 for other reasons.

NFPA 1, Uniform Fire Code™, 2003 edition.

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